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**MULTISENSORY
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PAD. Pages on Arts and Design

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ANVUR Class A Journal – Area 08, Sector 08/C1
Design and Technological Design of Architecture

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Publisher**AIAP Edizioni**

Associazione italiana design della comunicazione visiva

via A. Ponchielli 3 – 20129 Milano – Italy

aiap@aiap.it – www.aiap.it

PAD © ISSN 1972-7887

#30, Vol. 19, June 2026

www.padjournal.net

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REUSE AND REGENERATIVE BEAUTY

From Regenerated Spaces to Restorative Places

An Interdisciplinary Approach to Multisensory Reuse

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Keywords

Adaptive Reuse, Multisensory Installations, Environmental Psychology, Cross-modal Congruence, Proof of Concept.

Abstract

In the context of increasing urbanization and the growing presence of disused spaces, adaptive reuse can be reconsidered as a process capable of promoting psychophysiological well-being. This paper proposes an interdisciplinary theoretical model integrating interior design, environmental psychology, and cognitive neuroscience to explore whether disused spaces can be transformed into restorative places through a multisensory approach grounded in cross-modal congruence.

Drawing on Stress Reduction Theory (SRT), Attention Restoration Theory (ART), biophilic design principles, and neuroaesthetic studies, the paper argues that regenerative potential depends not only on the presence of nature, but on specific perceptual qualities such as organized variety, sensory congruence, fascination, and identity. These qualities are hypothesized to activate neurocognitive mechanisms related to emotional regulation and stress reduction.

To preliminarily test this model, a proof of concept was developed in a disused site through three multisensory installations characterized by different levels of sensory congruence.

The findings provide preliminary support for the hypothesis that perceived regenerativity can be modulated by the multisensory configuration of space and that cross-modal congruence plays a key role in shaping restorative experience, suggesting that the perceptual quality of the intervention may be central in enabling space to function as a regenerative device.

1. Introduction

Contemporary society is undergoing profound transformations driven by urbanization, economic change, and evolving social dynamics. While new urban spaces continue to be developed, many buildings have lost their original functions, increasing the presence of disused or underutilized spaces within the urban fabric. This condition reflects economic and social shifts that redefine the utility and meaning of built contexts over time (Sassen, 2008). At the same time, industrialization, technological development, and urban growth have gradually distanced everyday life from direct contact with natural systems.

This shift is particularly relevant when considering the relationship between space and human well-being. A growing body of research in psychology and related fields has shown that the settings people inhabit play a crucial role in shaping psychological states, cognitive functioning, and physiological responses to stress (Menatti & Casado da Rocha, 2016).

Urban contexts, characterized by high densities, sensory overload, and demanding attentional conditions, are often associated with increased cognitive fatigue and stress. Although living in cities provides important advantages in terms of access to education, culture, healthcare, and employment (Gruebner et al., 2017), several contextual and social factors typical of urban life have also been associated with higher risks of stress-related mental health conditions such as anxiety and depression (Peen et al., 2010). These risks are linked to factors including limited living space, sedentary lifestyles, exposure to intense sensory stimuli such as noise and artificial lighting, and the weakening of social networks (Hoare et al., 2019).

Against this background, research in environmental psychology has introduced the concept of *regenerative places*, defined as settings capable of restoring the cognitive and psychophysiological resources depleted by daily routine (Pazzaglia & Tizi, 2022). While early research associated restorative effects primarily with natural landscapes (Ulrich, 1983; Kaplan & Kaplan, 1989) – a preference explained by evolutionary predispositions (Oriens, 2014) – subsequent research has shown that built settings may also support restorative experiences when they possess specific perceptual and symbolic qualities (Bornioli & Subiza-Pérez, 2023). These findings raise important questions for interior architecture and design. As contemporary societies spend an increasing proportion of time in constructed contexts, the design disciplines are called to reconsider how spatial configurations can contribute to human well-being (Anzani, 2022). Rather than focusing exclusively on the formal or functional dimensions of interior architecture, recent perspectives advocate a systemic approach that considers the complex biopsychosocial relationships between humans, built spaces, and natural systems (Mallgrave, 2013).

At the same time, the widespread presence of disused buildings represents a potential resource for urban transformation. The adaptive reuse of existing structures can activate processes of spatial and social regeneration while preserving the historical and cultural identity embedded in the built heritage (Crespi, 2020; Anzani, 2021). In this sense, abandoned spaces may be interpreted as opportunities for reimagining the relationship between spatial design, perception, and well-being.

Against this scenario, the present study explores whether regenerated spaces can become restorative places. To address this question, the paper proposes an interdisciplinary theoretical model integrating interior design, environmental psychology, and cognitive neuroscience. The model assumes that the regenerative quality of built settings emerges from the interaction between spatial configuration and users' perceptual, cognitive, and emotional processes. Within this perspective, multisensory design is interpreted as a projective device capable of fostering restorative spatial experiences, particularly in contexts of adaptive reuse. To preliminarily explore the validity of this framework, the study develops a proof of concept implemented in a disused space. Through a set of multisensory installations characterized by different levels of sensory congruence, the experiment investigates how specific perceptual configurations may shape restorative experiences within reused contexts.

2. Theoretical Framework

Environments influence psychological well-being, cognitive functioning, and the physiology of stress, shaping neural structure and related cognitive-behavioral processes (Valentine et al., 2025). Within this field, particular attention has been given to *regenerative places*, which promote stress reduction, attentional recovery, and increased positive emotional states (Kaplan & Kaplan, 1989). These places operate by distancing individuals from routine, engaging involuntary attention, and offering stimuli that invite exploration (Pazzaglia & Tizi, 2022).

Building on the concept of *biophilia* (Wilson, 1984), *Stress Reduction Theory (SRT)* (Ulrich, 1983) suggests that reduced per-

ceived stress in green and blue areas is linked to an evolutionary predisposition toward the exploration and contemplation of natural settings. The progressive overcoming of the dichotomy between natural and built contexts has expanded the notion of *regenerativity* (Carrus & Scopelliti, 2015). This concept thus includes built spaces such as urban green areas (Carrus et al., 2013), museums (Kaplan et al., 1993), historically significant sites (Scopelliti et al., 2019), monasteries (Ouellette et al., 2005), architecturally distinguished neighborhoods (Karmanov & Hamel, 2008), city centers and public squares (Subiza-Pérez et al., 2021), commercial streets (Barros et al., 2021), cafés (Staats et al., 2016), and cemeteries (Nordh et al., 2017).

From a biopsychological perspective, *Attention Restoration Theory (ART)* (Kaplan & Kaplan, 1989) posits that prolonged cognitive effort leads to mental fatigue due to the depletion of attentional resources. Regenerative places mitigate this condition by reducing the use of directed attention and enabling its restoration through *fascination* – an effortless form of attention elicited by stimuli that automatically engage the observer.

Built spaces can exhibit significant regenerative potential when they facilitate cultural or recreational activities or integrate architectural and natural elements (Weber & Trojan, 2018). In this regard, aesthetic urban contexts have been described as settings that afford pleasant perceptual and sensory experiences associated with meaningful symbolic forms (Cuthbert, 2008). Such effects can be explained by the role of aesthetics and attractiveness in enhancing *legibility*, *familiarity*, and the perceived *meaning of places* (Nasar, 1994).

Environmental preference has been shown to be influenced by factors such as familiarity (*topophilia*), known meaning and value (*ecological aesthetics*), uniqueness (*genius loci*), historical expression (*cultural heritage*), and perceived care (*aesthetics of care*) (Tveit et al., 2006).

Accordingly, beauty should not be understood as a purely ornamental attribute, but as a neurobiological process that modulates the stress system. Aesthetic experience results from neural activation and involves the affective-cognitive evaluation of external stimuli (Comfort & Freitas, 2022), with implications for mental health: it generates hedonic pleasure and *cognitive self-reward* (Leder et al., 2004). Neuroaesthetic research has shown that aesthetic appreciation is associated with the activation of brain regions involved in higher-order emotional processing, decision-making, and reward. These include the medial orbitofrontal cortex (mOFC), ventromedial prefrontal cortex (vmPFC), anterior cingulate cortex (ACC), and the striatum (Chatterjee & Vartanian, 2014).

From a design standpoint, *aesthetics* and *beauty* – central design qualities since antiquity – lost prominence during the 20th century in favor of functionalist approaches (Coburn et al., 2017). Nevertheless, spatial design retains the capacity to either mitigate or exacerbate stress responses (Valentine et al., 2025). For instance, visual patterns that deviate from those found in nature may induce visual stress, with negative effects on health. Building facades that diverge from natural spatial properties have been shown to elicit increased hemodynamic responses in the primary visual cortex, indicating heightened

visual system activation (Le et al., 2017). Conversely, in line with ART, nature images promote visual engagement without excessive cognitive load (McDonnell et al., 2025). Indeed, the decreased blink rates observed in natural versus urban scenes reflect a more relaxed attentional state (Valtchanov & Ellard, 2015). Similarly, the fractal properties of natural forms enhance visual organization, contributing to stress reduction and overall well-being (Lavdas & Schirpke, 2020; Taylor, 2021). Beyond vision, the material properties of built environments further influence emotional and physiological responses. Among these, green building materials may improve indoor air quality, with benefits for human health (Khoshnava et al., 2020). Moreover, the texture and brightness of natural surfaces elicit more positive emotional responses than artificial ones (Tan et al., 2025), fostering aesthetically pleasing contexts.

A key aspect of aesthetic experience is its relationship with *perceptual fluency*, defined as the ease with which stimuli are processed. Greater fluency is associated with a higher likelihood of positive evaluations (Reber et al., 2004), whereas incongruent configurations tend to elicit negative emotional responses (Ikeda et al., 2015). Environmental preference is shaped by perceptual qualities such as *coherence* and *complexity* (Kaplan & Kaplan, 1989). Coherent spaces facilitate comprehension through well-organized, repeated elements, whereas complex ones encourage exploration through a richness of stimuli. This relationship is further described by Berlyne's (1971) inverted U-shaped model between complexity and preference. According to this model, optimal levels

of stimulation produce the highest degree of appreciation, while both under- and over-stimulation reduce it. Complexity has also been shown to positively influence experience in cross-modal contexts (Cao & Chen, 2024).

Within multisensory settings, signals from different sensory modalities that exhibit cross-modal correspondences are processed as *congruent* and mutually reinforcing. This facilitates more fluent, rapid, and efficient processing (Spence, 2020), resulting in a sense of cognitive ease associated with both aesthetic preference and decision-making. Conversely, incongruent multisensory stimuli are more complex to process, requiring greater cognitive effort and negatively affecting users' preferences and experience (Bruno, 2022).

These findings suggest that design should provide *symbolic and affective qualities* that attract individuals (Nasar, 1994). This strategy fosters timeless, harmonious, and functional spaces that *restore* the balance between built and natural systems. In this sense, contemporary trends such as the adoption of vintage aesthetics and the reuse of previously used objects, including furniture and decorative elements, can be interpreted within this broader cultural orientation (Nowakowski, 2024). If environmental preferences derive from both evolutionary predispositions and culturally shared meanings, the reuse of abandoned spaces can become a powerful device for identity-based and affective reactivation. The characteristics of the landscape influence the meanings attributed to a place, which in turn shape attachment and satisfaction (Anzani, 2020).

On this basis, *restoration* can be understood as emerging from specific perceptual qualities that trigger favorable neurocognitive mechanisms – such as *organized variety*, *cross-modal congruence*, *balanced relationship between coherence and complexity*, *fascination*, and *historical identity*. Consequently, built spaces and reuse interventions can be designed to be intentionally regenerative, independently of the presence of nature itself.

3. Research Model and Hypotheses

3.1. Proposed Research Model

Building on the theoretical framework discussed, this study proposes a *conceptual model* (Fig. 1) that translates these perceptual qualities into a set of design variables applicable to adaptive reuse interventions. Rather than being limited to natural settings, such qualities can also emerge within constructed environments when spatial configurations are capable of activating perceptual and cognitive mechanisms that support emotional regulation and attentional restoration.

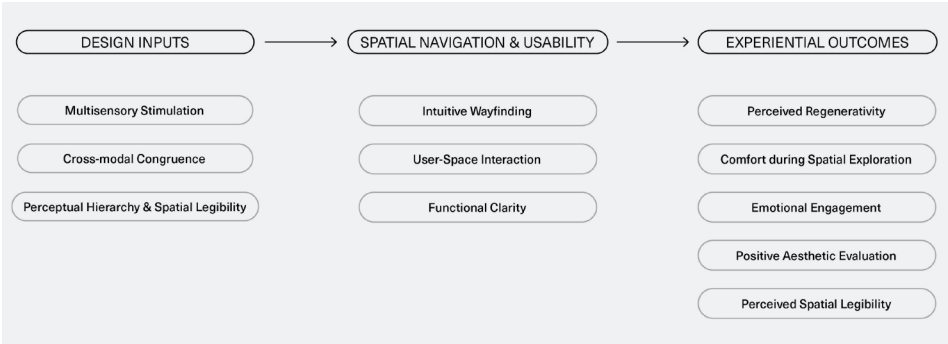


Figure 1. Conceptual model of perceptual regenerativity in multisensory adaptive reuse environments (Authors' chart, 2026).

Within this perspective, the regenerative potential of reused spaces is interpreted as the outcome of an interaction between spatial configuration and users' perceptual, cognitive, and emotional processes. The model therefore focuses on a *set of design inputs* that operationalize theoretical principles into spatial strategies (Fatone & Anzani, 2026).

The first input concerns *multisensory stimulation*, understood as the coordinated activation of multiple sensory channels through the use of materials, light, sound, textures, and smells. In line with the notion of *well-balanced sensory variety* discussed in biophilic design research (Kellert, 2008), multisensory configurations can increase experiential richness while maintaining perceptual balance.

The second input relates to *cross-modal congruence* (Spence, 2020), referring to the consistency between stimuli perceived through different sensory modalities. Such consistency facilitates perceptual processing and contributes to a more fluent and aesthetically coherent spatial experience.

The third input concerns *perceptual hierarchy* and *spatial legibility*, which describe the structured organization of environmental stimuli that allows users to orient themselves within the space while sustaining exploratory interest. Concepts such as *coherence*, *legibility*, *complexity*, and *mystery* (Kaplan, 1987) define the perceptual conditions under which spaces are perceived as both understandable and engaging.

Multisensory installation design is thus interpreted not merely as a strategy for enhancing sensory stimulation, but as a perceptual device that shapes how users emotionally and

cognitively experience space. By leveraging cross-modal congruence, such configurations enhance spatial comprehension and strengthen user engagement with the environment. When multisensory stimuli are coherently organized within a clear perceptual structure, the resulting configuration is hypothesized to support restorative spatial experiences, fostering perceived regenerativity, improved comfort, emotional engagement, and positive aesthetic evaluation.

3.2. Research Hypotheses

The study formulates a primary hypothesis concerning the regenerative potential of multisensory adaptive reuse. It is assumed that disused built complexes, when reconfigured through a multisensory installation approach grounded in cross-modal congruence, can be perceived as restorative places capable of supporting psychological regeneration.

More specifically, the model hypothesizes that higher levels of sensory congruence and perceptual organization can positively influence users' experience of space. These conditions are expected to enhance positive emotional responses, increase fascination and exploratory engagement, improve aesthetic evaluation, and facilitate spatial legibility. Such perceptual and experiential responses are considered indicators of the regenerative quality of the designed environment.

To preliminarily test these assumptions, the study develops a *proof of concept* in a disused building, investigating how different degrees of sensory congruence may influence perceived comfort and regenerative experience.



Figure 2. Fire Station in Mortara (Authors' photo, 2025).

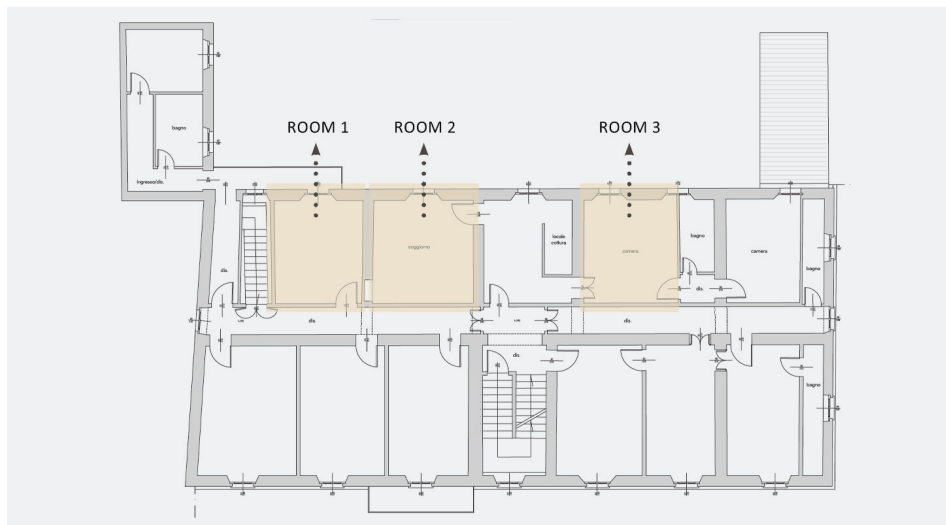


Figure 3. Selected rooms to be set up (Authors' drawing, 2025).

4. Proof of Concept

4.1. Methodology and Instruments

The experiment was conducted in the former Fire Station in Mortara (Pavia), decommissioned in 2019 and located in the historic center of the city (Fig. 2). The site was selected due to its lack of a defined current function and its strong historical and symbolic character, making it a suitable context for investigating how temporary and reversible interventions can alter spatial perception and transform a disused space into a place of experience.

A sample of nine design students from Politecnico di Milano was involved and divided into three groups, each tasked with developing a multisensory installation (A1, A2, A3) within a different room of the building (Fig. 3). General design guidelines were provided, emphasizing the role of multisensory interaction and cross-modal congruence in shaping the atmosphere, while allowing participants to independently translate theoretical principles into spatial configurations. Each installation was structured around a specific pairing of sensory modalities: A1 (sight and hearing), A2 (sight and smell), and A3 (sight and touch).

The setups combined existing elements found within the building (rugs and photographs) with lightweight materials including organza, cotton, leaves, and branches, ensuring minimal impact on the original space (Fig. 4). After completing the setups, participants were invited to individually explore the other rooms for five minutes per space.



Figure 4. A1, A2, A3 setups (Authors' photo, 2025).

Following each exploration, participants completed a mixed-method questionnaire combining Likert scales and open-ended responses. In line with the exploratory scope of the proof of concept, the data were analyzed descriptively: Likert responses were translated into bar charts to compare participants' evaluations across the three installations, while open-ended answers were examined through a qualitative thematic reading. Both sources of data were then integrated to inform the final interpretation, with the aim of verifying whether the congruence between stimuli played a role in shaping the regenerative experience. Recurring terms, emotional descriptors, and interpretative patterns were grouped according to the main analytical dimensions of the study, namely multisensory richness, cross-modal congruence, atmosphere, emotional engagement, and spatial legibility.

Given the limited sample size ($n=9$) and the purposive selection of participants with design training, findings should be interpreted as preliminary indications rather than generalizable results.

4.2. Results

The analysis suggests that the *integration of multiple sensory stimuli* played a key role in shaping participants' experience of the setups. Their effectiveness appeared to depend

on *sensory balance*: too many or too few stimuli seemed to affect their quality. The combination of visual and olfactory stimuli generated an enveloping and engaging experience, with A2 emerging as the most immersive setup in this sample (Fig. 5). Likert-scale trends confirmed A2 as the highest scorer for perceived multisensoriality, a result further supported by qualitative responses describing the setup as emotionally engaging and memorable. The olfactory element, combined with the visual impact, showed particular relevance in driving emotional engagement, as the evocative power of smell complemented the analytical capacity of sight. This is consistent with studies on sensory perception, according to which *sight*, being the dominant sense in cognitive processes, facilitates the understanding of space, while *smell* has a direct influence on emotions through its connection to the limbic system (Schreuder et al., 2016).

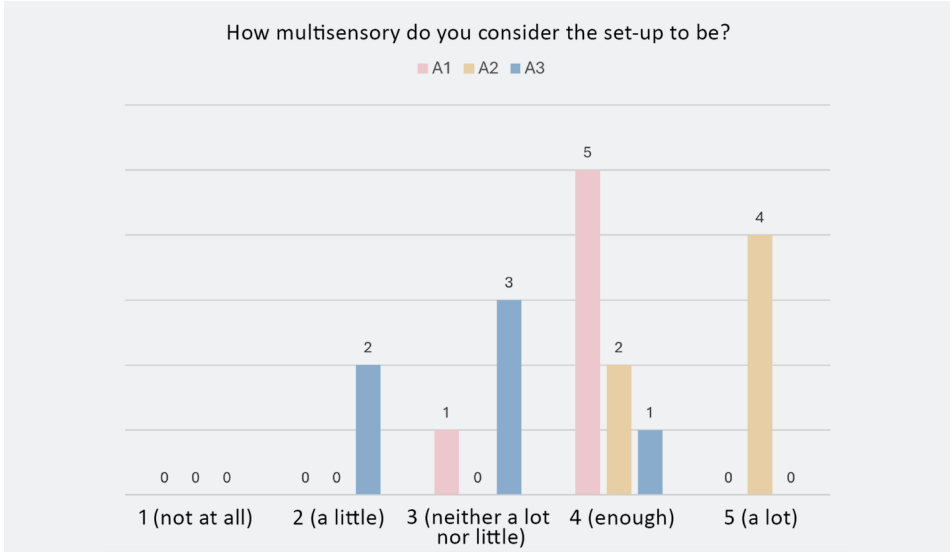


Figure 5. Multisensoriality assessment (Authors' diagram, 2025).

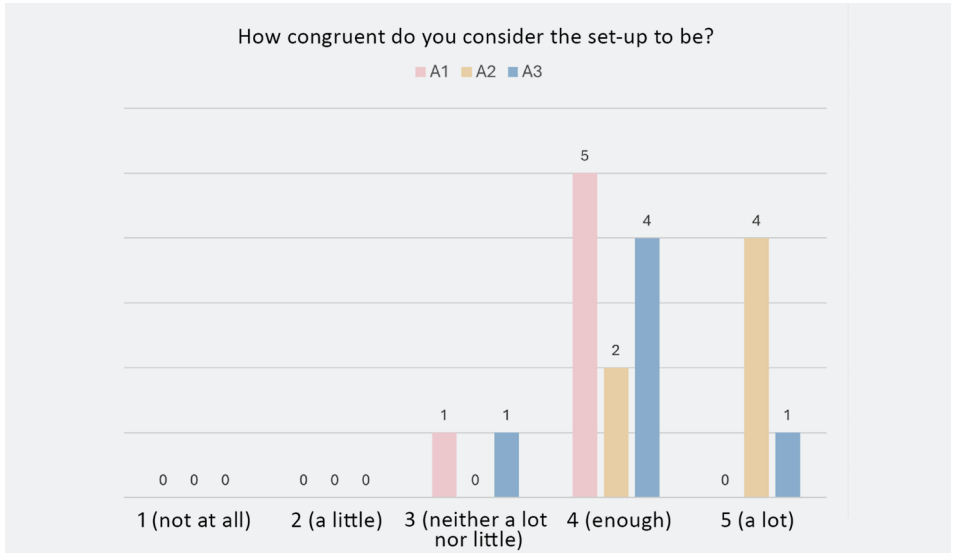


Figure 6. Congruence assessment (Authors' diagram, 2025).

The *balance between stimulus intensity and coherence* appeared to play an important role in shaping an effective experience, preventing perceptual overload that could compromise the enjoyment of the space. *Congruence* in multi-sensory displays proved closely linked to *spatial legibility* and the clarity of the design language. Although A2 received the highest Likert ratings for congruence (Fig. 6), qualitative evidence pointed to A1 as the most congruent setup overall, conveying a clearer sense of spatial order, continuity, and legibility through its layout and visually homogeneous materials. This observation aligns with the theory of cross-modal correspondences (Spence, 2020) and the notion of perceptual fluency (Reber et al., 2004): the brain more easily processes mutually reinforcing stimuli, yielding a more fluid and intuitive experience.

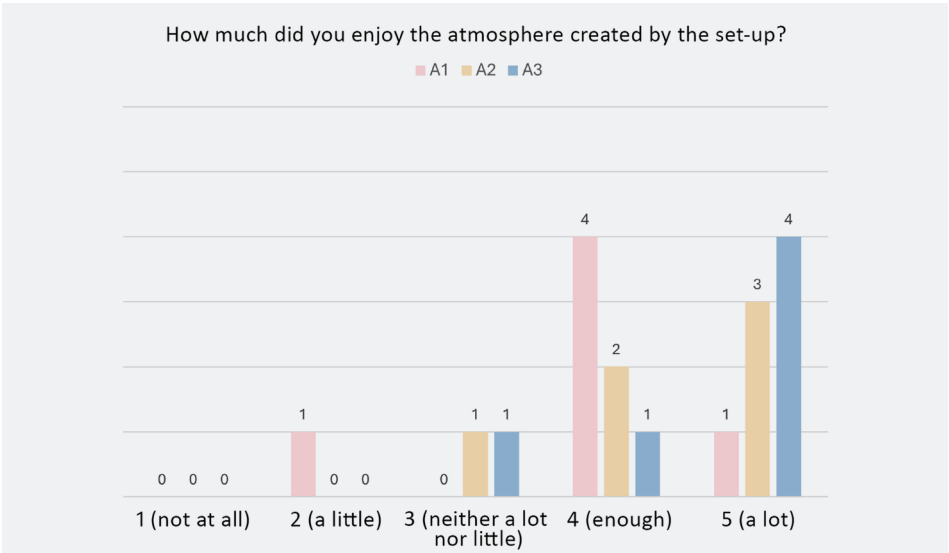


Figure 7. Atmosphere assessment (Authors' diagram, 2025).

The *orchestration of design factors* – lighting, colors, materials, and arrangement of elements – appeared central to the construction of *atmosphere*, with high appreciation emerging for both A2 and A3 (Fig. 7). A3 received the highest appreciation: its chromatic, visual, and material coherence created an ethereal and relaxing environment. A2 combined notable atmospheric appreciation with strong scores for multisensoriality and congruence, though its intense sensory layering proved more demanding to interpret. This suggests that positive perceptual experience may depend on a balance between stimulation, coherence, and atmosphere, consistent with Berlyne's (1971) complexity-preference model.

5. Conclusions

The proof of concept provides preliminary evidence that the *restorative quality* of built assets may be activated through de-

sign strategies grounded in multisensory perceptual congruence. The findings suggest that physical regeneration, when supported by carefully calibrated multisensory installations, may enhance the perceptual and emotional significance of abandoned spaces. Multisensory installations appear capable of attracting attention in a non-invasive way, conveying meanings and emotions that strengthen users' involvement with space and contribute to experiences of well-being and perceived regenerativity. Effective multisensory design should thus *balance stimulation, coherence, and atmosphere* to foster places that are engaging and legible, avoiding both perceptual overload and excessive neutrality.

From a design perspective, the study underscores the importance of structuring multisensory interventions through *coherent and hierarchically organized configurations*, in which each element may contribute to a unified experiential framework. This approach may be particularly relevant in the reuse of disused spaces, where aesthetic, cultural, and nature-related elements contribute to reinforcing place identity and experiential meaning. Preliminary findings point to the relevance of cross-modal correspondences in facilitating spatial comprehension and reducing cognitive load, as well as to the potential of *olfactory stimuli as catalysts of emotional engagement*. At the same time, effective design may require a calibrated *balance between coherence and variation*, allowing sensory contrasts to sustain curiosity and exploration without compromising clarity and orientation. The orchestration of materials, colors, and lighting may contribute to atmospheres that are both immersive and intelligible.

These findings should be read in light of the exploratory nature of the proof of concept. The small sample size, the participants' shared design background, and the reliance on self-reported perceptual and emotional evaluations preclude statistical generalization or full empirical validation of the proposed conceptual model. Rather, the study should be understood as a preliminary application of the research model within a specific disused context, aimed at investigating whether design inputs based on multisensory stimulation, cross-modal congruence, and perceptual organization could affect users' perceived comfort and regenerative experience at a small scale. These limitations define a clear agenda for future research, which should involve larger samples, different adaptive reuse contexts, and complementary assessment methods, including biometric or physiological measures to capture perceptual, emotional, and attentional responses more precisely.

By integrating design, environmental psychology, and neuroscience, the study enabled *preliminary design orientations* for adaptive reuse contexts, pointing toward spatial transformation as a potential regenerative mechanism for public health and collective well-being. Such a process should be conceived not merely as material recovery, but as a form of spatial and perceptual reconfiguration capable of activating neurocognitive mechanisms, positioning the multisensory interior as a *device for practices of care*.

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V

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His research spans forest genetics, viticulture, and data-informed analyses of environmental and socio-economic systems, including work on power imbalances within commercial structures. His current work focuses on multisensory design and more-than-human approaches, exploring how ecological systems thinking can inform spatial practice and support the development of responsive, relational environments.

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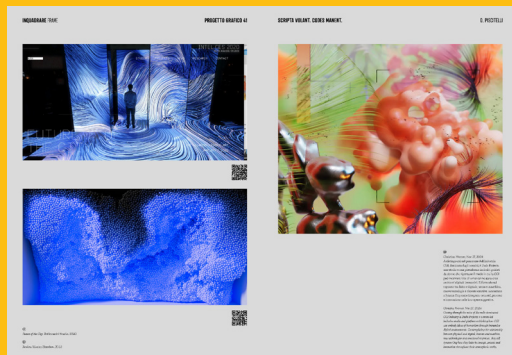
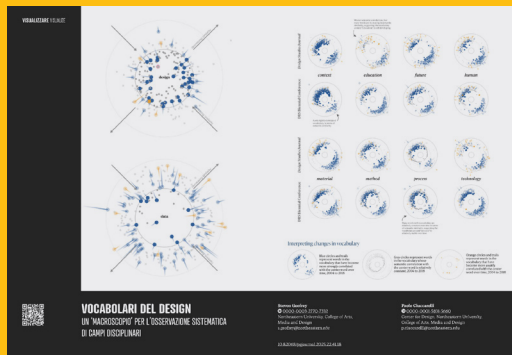
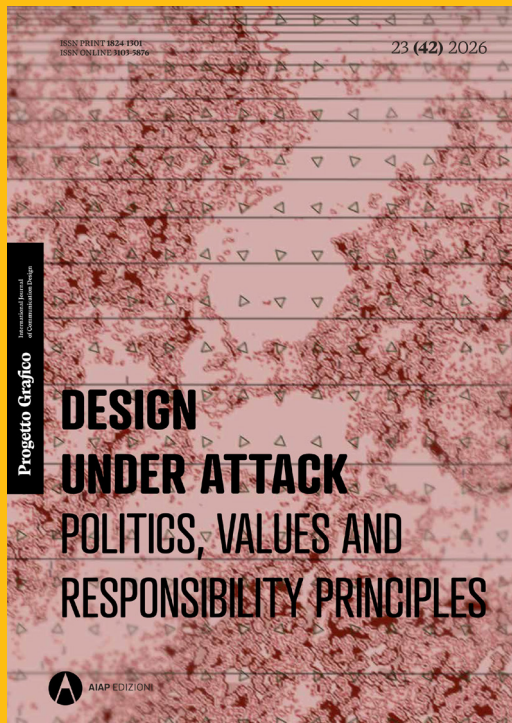
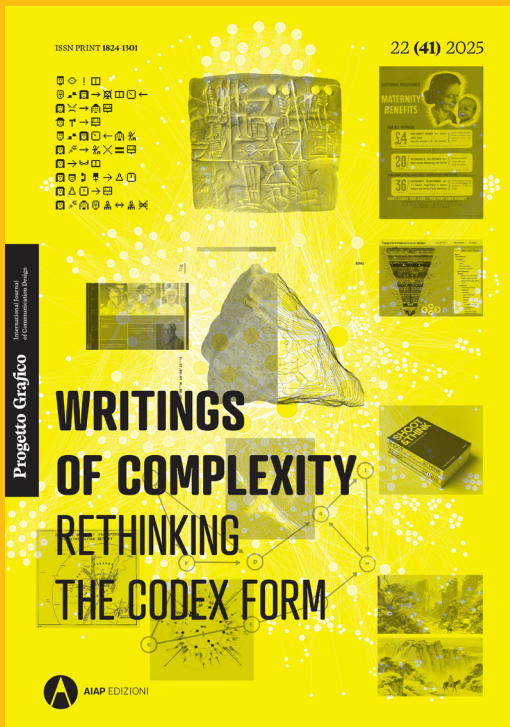
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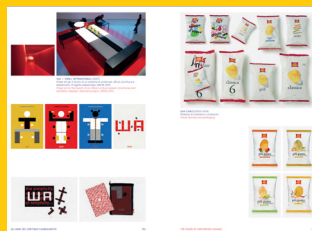
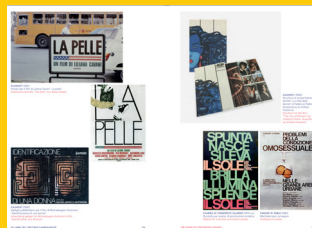
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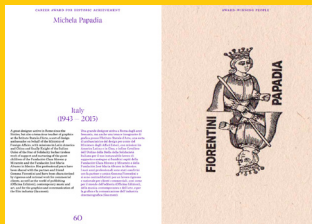
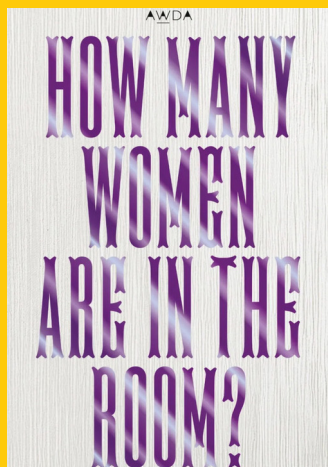
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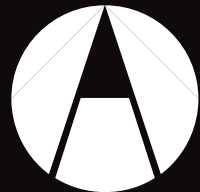
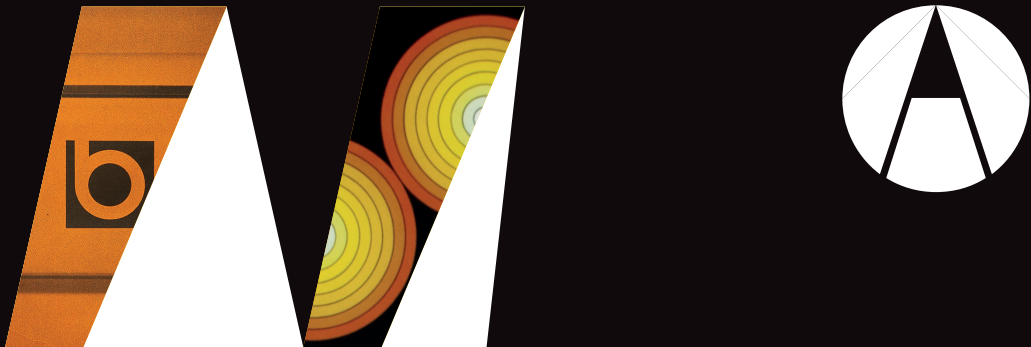
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PAD. Pages on Arts and Design

International, peer-reviewed,
open access journal
ISSN 1972-7887

#30, Vol. 19, June 2026

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